Riverina Oils and BioEnergy

Integrated Oilseed Processing Plant

Appendix F
Soil Suitability Report

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Draft Soil Suitability Report

Riverina Oil and Bio Energy Pty Ltd

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1. INTRODUCTION

This document describes the soil suitability for irrigation of treated effluent at the Riverina Oil and Bio Energy Pty Ltd (ROBE) Integrated Oilseed Processing Plant (IOPP) site. The Project Approval conditions issued for the IOPP required that the soil suitability be a part for the Soil and Water Management Plan (SWMP) and be prepared and implemented to the satisfaction of the Director General of the Department of Planning.

2. SITE SELECTION

The proposed irrigation site was chosen for its size (25 hectares) and proximity to the IOPP, **figure 1**.

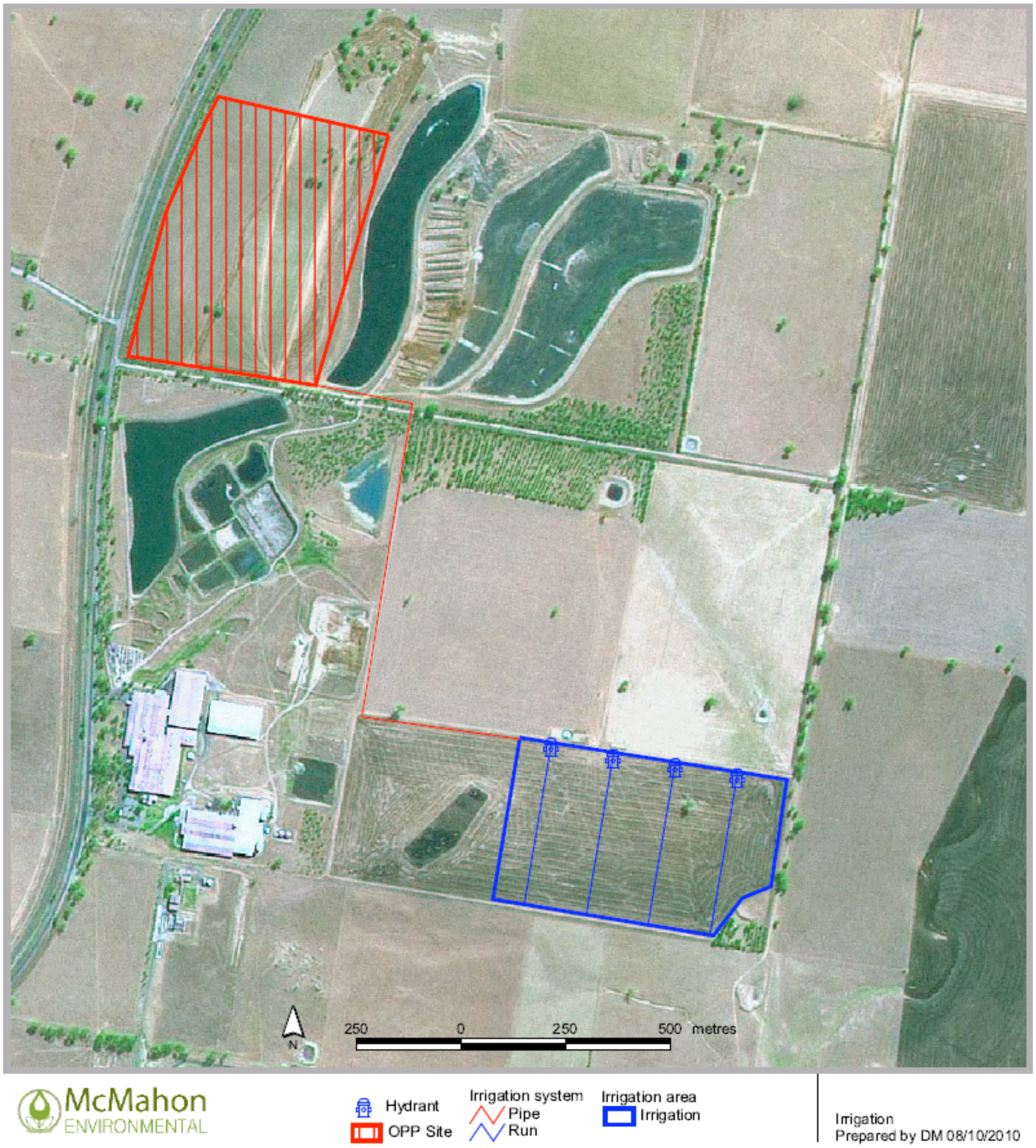

Figure 1: Irrigation site

2.1 Desktop review

A desktop review of the soil, lithology, groundwater and geology within the planned irrigation area has been undertaken and are as follows:

Soil
The site lies within the soil mapping units coded as MY10 from the Digital Atlas of Australian Soil (BRS, 1991). The map unit key My10 is described as:

"My10"
"Undulating to rolling country with some long broad slopes, some tors: chief soils are neutral red earths (Gn2.12) often gritty and/or sandy, with some neutral yellow earths (Gn2.25) often locally prominent; and in the most easterly occurrences of the unit some (Gn2.15) soils. Associated are: variable areas of hard neutral and alkaline red soils (Dr2.32 and Dr2.33); scattered ridges and knolls of unit Qb1O; and smaller areas of (Dy) soils. The eastern occurrences of this unit and its companion unit Qb1O, taken together, have some features in common with unit Mu1. Ironstone gravels are of erratic occurrence. Data are limited. Occurs on sheet(s): 3"

The site lies within the soil landscape mapping unit "East Bomen" from the Department of Land and Water Conservation1 (1997) Soil *Landscapes of the Wagga Wagga 1:100,000 Sheet*. The map unit key is as follows:

Regionally it has a distribution from areas north of the Murrumbidgee Floodplain to the regions near Yarragundry-Collingullie and a small area south of Uranquinty. The underlying geology comprises Silurian aged granites, mainly Wantabadgery Granodiorite and Collingullie Granite, with occasional Burrandana Granite. The topography comprises undulating rises and minor low hills with slope gradients mostly 3-10%. The landform generally consists of crests and ridges, long waning slopes and shallow drainage lines. The vegetation of this soil unit is largely cleared, with the exception of some residual areas of tall woodland in Crown reserves and along a few roads. Predominant land uses include cropping for wheat with minor barley and cereal rye, and grazing on both stubble and improved pastures.

The dominant soil material is shallow to moderately deep (40-150cm) Eutrophic Red Dermosols on crests and ridges; deep (80-200cm) Eutrophic Red Dermosols on slopes; and moderately deep (80-150cm) Eutrophic Brown Dermosols in drainage lines.

Lithology and Geology
The site lithology is distributed over one unit: Wantabadgery Granites with a dominant lithology of Silurian-Devonian S-type Granodiorites.

Depth to seasonal high water table (metres)
Based on reported water bearing zone information detailed in registered groundwater bore data from the Department of Climate Change and Water (DECCW) website (http://test.nratlas.nsw.gov.au) indicative depth to groundwater reported within the site area varies considerably from 4 to 100 metres below ground level.

2.2 Soil Survey

Detailed soil investigations should be confined to potentially suitable sites identified from the preliminary investigations. The aim of the detailed survey is to:

- confirm the suitability of the proposed irrigation site
- identify any ‘moderate’ soil limitations that will require special management practices, **table 2**
- set up a baseline for a monitoring program

Procedure of work
18 soil pits were investigated by backhoe and full profile descriptions recorded, **figures 2 & 3**. All pits were excavated to approximately 1.5 metres depth.

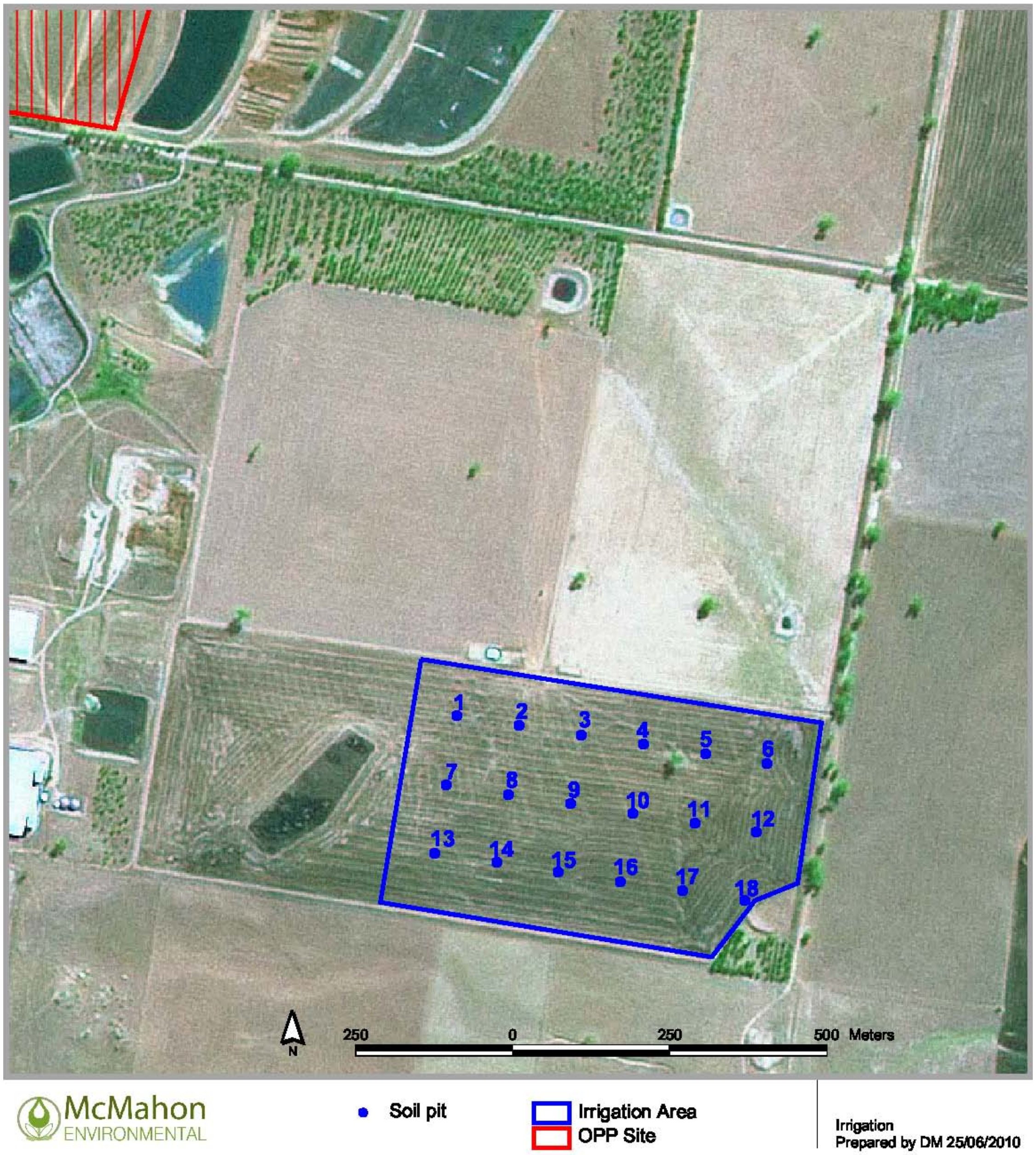

Figure 2: Soil pit locations on satellite image

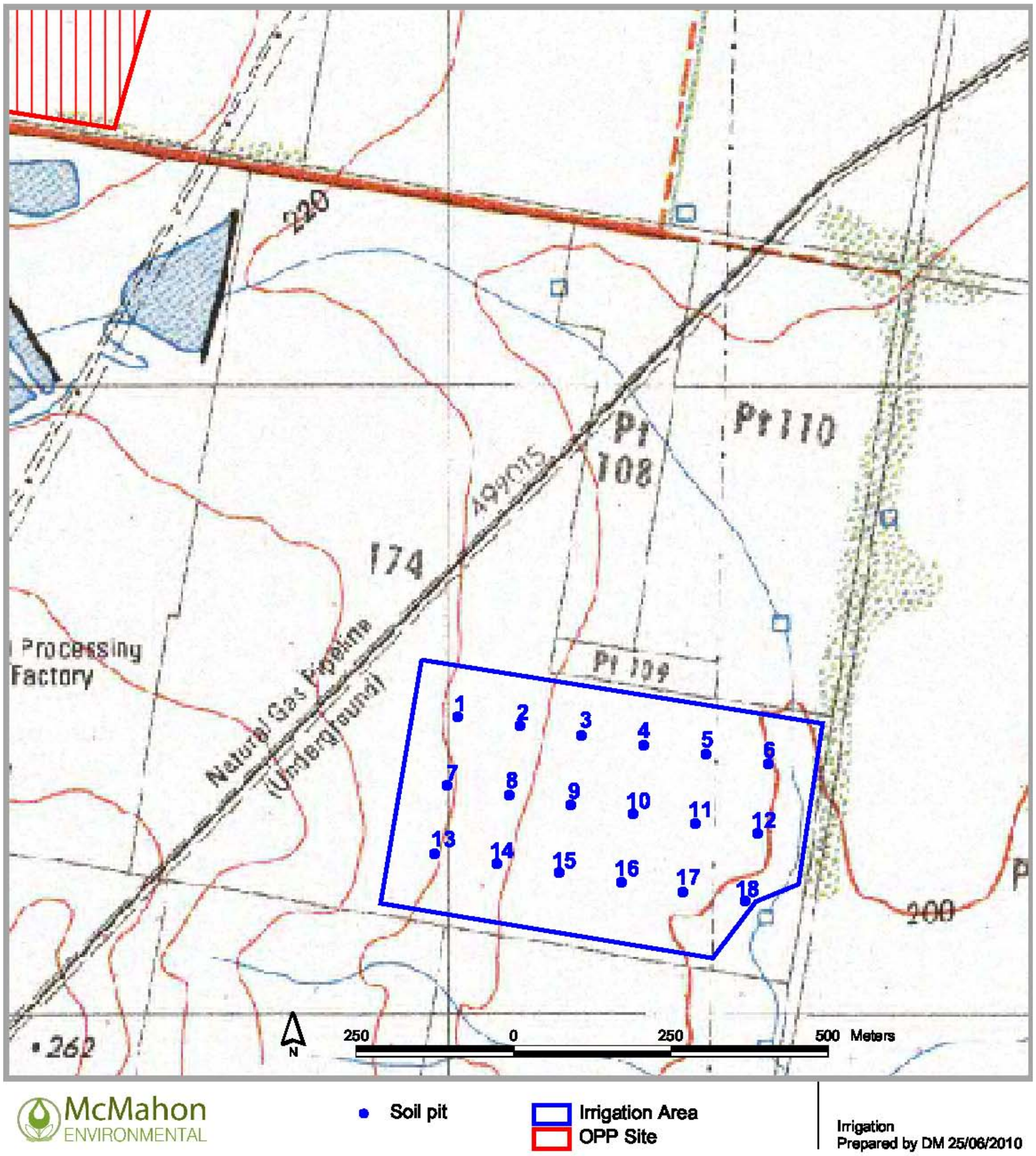

Figure 3: Soil pit locations on topographic map

2.3 Results

Site landscape is a gently to very gently inclined simple slope running in a west to east direction, **figure 4**. The local relief is approximately 20 metres with an approximate gradient of 3%. There are no incised or formed drainage lines present. Soils are deep (>150 cm), sandy loam to fine sandy loam topsoils (10 to 20 cm) overlying a silty clay to sandy clay loam.

Figure 4: Photograph of site facing east taken from pit 13

The soils belong to the **Dermosol** soil classification and are defined as lacking strong texture contrast between the A and B horizons and with a structured B horizon. Dermosols are also classified as **Red and Yellow Podzolic Soils** and **Red Earths**. They are derived from the granitic parent material which is naturally acidic and rich in silt and aeolian dust (parna).

The profiles mainly consist of three horizons:
1. A darker fine sandy loam organic surface layer (A horizon);
2. A structured subsurface horizon (B horizons);
3. Clayey and silty subsoil that is characterised by the accumulation of amorphous organic and/or mineral compounds and some mottling, (C horizon).

A photograph of the typical soil profile can be seen in **figure 5**.

Figure 5: Typical soil pit profile

The soil is deep, friable, porous and non-cracking that is currently well-drained and aerated, brittle when dry, but soft and smeary when wet. Field tests showed that the soils do not swell and disperse, but the subsoils are generally low in organic matter. In general, a combination of soil depth, slope, very low salinity, open porosity, fine friable subsoil structure, physically unrestricted roots and water penetration, large water holding capacity, good drainage, aeration, water and heat transmission, workability and trafficability, are some of the many advantages of these soils. These favourable properties make them highly suitable for the intended use, and the soils do not require physical amelioration before irrigation. Soil pit log sheets can be seen in the **Appendix**.

2.4 Soil Analysis

12 soil samples were taken for analysis and tested for properties outlined by the DECCW, **table 1**. Samples of representative slope and soils types were taken for analysis. The soils from the upper, middle and lower slope were bulked for analysis, being: Upper – pits, 1,2,7,8,13,14; Middle – 3,4,9,10,15,16; and Lower – 5,6,11,12,17,18. Soils were tested for:

Topsoil (0-10cm) samples: pH, Electrical Conductivity (EC), Total Nitrogen, Total Phosphorus, Exchangeable Sodium Percentage (ESP), Cation Exchange Capacity (CEC), Available Phosphorus, Phosphorus Sorption Capacity and Emerson Aggregate Test (EAT). Subsoil samples were collected at the 10-30cm, 30-60cm and 60-100cm and be analysed for: pH, EC & ESP. A summary of results can be seen in **table 1** and a full lab report can be seen in the **Appendix**.

2.4.1 Topsoil Analysis
Samples from the 0-10cm depth were taken as topsoil samples.

pH & EC

Topsoil pH is classed as very strongly acid, Rayment and Bruce 1982, and the addition of superfine agricultural lime at a rate of 2.5 tonnes per hectare is recommended.

EC is a salinity indicator and samples are classified as non saline, Charman and Murphy, 1991.

CEC and ESP

CEC is less than 5 which is typical of the dystrophic nature of soils in the locale. The soil is classed a non sodic, Hazelton and Murphy, 2007.

Total Nitrogen, Total & Available Phosphorus and Phosphorus Sorption Capacity

Nutrients appear in check and are typical of agricultural soils in the locale. Available phosphorus is slightly below threshold levels and the addition of phosphorus fertiliser prior to cropping is recommended.

Emerson Aggregate Test

Emerson Aggregate Tests returned class numbers 3 and 5. Classes 3 and 5 indicates a soil that is ‘unlikely to be sodic’, Hazelton and Murphy, 2007.

2.4.2 Subsoils
Subsoil samples were collected at the 10-30cm, 30-60cm and 60-100cm and were analysed for: pH, EC & ESP.

pH & EC

pH is classed as very strongly acid, Rayment and Bruce 1982, and the addition of superfine agricultural lime at a rate of 2.5 tonnes per hectare is recommended.

EC is a salinity indicator and samples are classified as non saline, Charman and Murphy, 1991.

Cation Exchange Capacity and Exchangeable Sodium Percentage

CEC increases with depth which is typical of increasing clay content and base status.
The soil is classed as non sodic owing to a very low ESP, Hazelton and Murphy 2007.

Table 1: Soil Analysis

A 0-10	Top	Middle	Bottom	**Mean**
Aluminium meq/100g	0.28	0.06	0.08	**0.14**
Calcium meq/100g	2.29	2.14	3.19	**2.54**
EAT	5	3(1)	3(1)	**n/a**
EC uS/cm	297	301	317	**305**
Magnesium meq/100g	0.74	0.59	0.87	**0.73**
Total Nitrogen mg/kg	924	898	940	**921**
Phosphrous Buffer Index	41.2	71.7	57.9	**56.9**
pH CaCl2	4.9	4.4	4.7	**4.7**
Phosphorus Available mg/kg	27.6	25.6	25.6	**26.3**
Total Phosphorus mg/kg	116	146	145	**136**
pH H2O	4.8	4.4	4.7	**4.6**
Potassium meq/100g	0.71	0.66	1.08	**0.82**
Sodium meq/100g	0.11	0.03	0.02	**0.05**
Total Kjeldahl Nitrogen mg/kg	924	898	940	**921**
Cation Exchange Capacity	4.13	3.48	5.24	**4.28**
ESP	2.7	0.9	0.4	**1.3**
B 10-30	Top	Middle	Bottom	**Mean**
Aluminium meq/100g	0.44	0.22	0.05	**0.24**
Calcium meq/100g	4.3	3.06	7.4	**4.9**
EC uS/cm	407	347	509	**421**
Magnesium meq/100g	1.73	1.13	3.49	**2.12**
pH CaCl2	4.5	4.3	5.4	**4.73**
pH H2O	4.6	4.4	5.4	**4.8**
Potassium meq/100g	0.68	0.7	1.24	**0.87**
Sodium meq/100g	0.3	0.05	0.02	**0.12**
CEC	7.45	5.16	12.2	**8.3**
ESP	4.0	1.0	0.2	**1.7**
C 30-60	Top	Middle	Bottom	**Mean**
Aluminium meq/100g	0.38	0.1	0.09	**0.19**
Calcium meq/100g	5.3	5.48	9.06	**6.6**
EC uS/cm	432	436	568	**479**
Magnesium meq/100g	4.21	3.58	3.98	**3.92**
pH CaCl2	4.6	4.6	5.2	**4.80**
pH H2O	4.7	4.7	5.3	**4.9**
Potassium meq/100g	0.56	0.56	1.04	**0.72**
Sodium meq/100g	0.27	0.21	0.07	**0.18**
CEC	10.72	9.93	14.24	**11.6**
ESP	2.5	2.1	0.5	**1.7**
D 60-100	Top	Middle	Bottom	**Mean**
Aluminium meq/100g	0.07	0.04	0.16	**0.09**
Calcium meq/100g	7	5.83	7.53	**6.8**
EC uS/cm	686	501	610	**599**
Magnesium meq/100g	6.2	5.19	4.95	**5.45**
pH CaCl2	4.5	4.7	4.9	**4.70**
pH H2O	4.6	4.8	4.9	**4.8**
Potassium meq/100g	0.9	1.06	1.22	**1.06**
Sodium meq/100g	0.28	0.37	0.14	**0.26**
CEC	14.45	12.49	14	**13.6**
ESP	1.9	3.0	1.0	**2.0**

2.5 Site Suitability in relation to the DEC guidelines

The site is highly suitable for irrigation when compared to the DECCW guidelines. The following DECCW guidelines was used as guide for identifying soil limitations and selecting appropriate amelioration measures, **table 2**.

Table 2: Typical soil characterises for effluent irrigation systems

Property	Limitation			Restrictive Feature
	Nil or Slight	Moderate	Severe	
Exchangeable sodium percentage (0–40 cm)	0–5	5–10	> 10	structural degradation and waterlogging
Exchangeable sodium percentage (40–100 cm)	< 10	>10	–	structural degradation and waterlogging
Salinity measured as electrical conductivity (ECe) (dS/m at 0–70 cm)	< 2	2–4	> 4	excess salt may restrict plant growth
Salinity measured as electrical conductivity (ECe) (dS/m at 70–100 cm)	< 4	4–8	> 8	excess salt may restrict plant growth, potential seasonal groundwater rise
Depth to top of seasonal high water table (metres)	> 3	0.5–3	< 0.5	poor aeration, restricts plant growth, risk to groundwater5
Depth to bedrock or hardpan (metres)	> 1	0.5–1	< 0.5	restricts plant growth, excess runoff, waterlogging
Saturated hydraulic conductivity (Ks, mm/h, 0-100 cm)	20–80	5–20 or >80	<5	excess runoff, waterlogging, poor infiltration
Available water capacity (AWC, mm/m)	> 100	< 100	–	little plant-available water in reserve, risk to groundwater
Soil pHCaCl2 (surface layer)	> 6–7.5	3.5–6.0 > 7.5	< 3.5	reduces optimum plant growth
Effective cation exchange capacity (ECEC, cmol (+)/kg, average 0–40 cm)	> 15	3–15	< 3	unable to hold plant nutrients
Emerson aggregate test (0–100cm)	4, 5, 6, 7, 8	2, 3	1	Poor structure
Phosphorus (P) sorption (kg/ha at total 0–100 cm)	high	moderate	Low	unable to immobilise any excess phosphorus

Based on the soil analysis and physical characteristics of the soil, the site is highly suitable for irrigation with no severe limitations in comparison to the DECCW guidelines, **table 3**. Topsoil pH and CEC have been identified as having moderate limitations but can be ameliorated with the addition of lime to raise soil pH and subsequently the CEC. The low topsoil pH and CEC is typical of agricultural soils in the locale.

Table 3: Site suitability in relation to DECCW guidelines

Property	Comments
Exchangeable sodium percentage (0–40 cm)	ESP in the A & B horizons returned results of below 5. The highest reading was 4 at a depth of 10-30cm in the upper slope.
Exchangeable sodium percentage (40–100 cm)	All ESP results in the C horizon and below are below 5. The highest result was an ESP of 3 at a depth of 60 to 100cm in the middle slope.
Salinity measured as electrical conductivity (EC) (dS/m at 0–70 cm)	Soil salinity in the A & B horizons were all less <0.57 dS/m.
Salinity measured as electrical conductivity (EC) (dS/m at 70–100 cm)	Soil salinity in the sub soil below the C horizon were <0.69 dS/m.
Depth to top of seasonal high water table (metres)	No free groundwater was encountered during excavation.
Depth to bedrock or hardpan (metres)	No bedrock or hardpans were experienced during excavation.
Saturated hydraulic conductivity (Ks, mm/h, 0-100 cm)	Ks overall is classed as "moderately permeable" with no problems associated with infiltration, water logging or excessive runoff.
Available water capacity (AWC, mm/m)	AWC is calculated to be ~120mm/m indicating good AWC for plants.
Soil pHCaCl2 (surface layer)	Soil pH is very strongly acid and the application of lime is recommended.
Effective cation exchange capacity (ECEC, cmol (+)/kg, average 0–40 cm)	CEC in the A & B horizons ranged from 3.5 to 14.2 which is typical of the soils of the locale.
Emerson aggregate test (0–100cm)	Topsoil samples returned results that are 'unlikely to be sodic'
Phosphorus (P) sorption (kg/ha at total 0–100 cm)	Phosphorus Sorption ranges from low to moderate in the topsoil tested. Owing to the predicted low phosphorus load in the wastewater this is not considered a limitation. Soil generally in the locale has an inherent low phosphorus sorption capacity.

Methodology for establishing the soil water regime

The soil water regime is based on the approach presented in the Australian Soil & Land Survey Field Handbook 3rd Edition The National Committee on Soil and Terrain CSIRO 2009. The soil water regime is based on Soil Permeability and Soil Drainage and is describes as follows:

Permeability, Ks (saturated hydraulic conductivity) and is graded in mm per day and broken into 4 classes: 1 - Very Slowly permeable (<5mm/day); 2 - slowly permeable (5-50mm/day); 3 - moderately permeable (50-500mm/day); and 4 - highly permeable (>500mm/day).

Permeability is independent of climate and drainage, and - as applied to a soil – is controlled by the potential to transmit water (saturated hydraulic conductivity, Ks) of the least permeable layer of the soil. Therefore it is inferred from attributes of the soil such as structure, texture, porosity, cracks and shrink-swell properties.

Drainage is broken into 6 classes being: 1 - Very poorly drained; 2 - Poorly drained; 3 - Imperfectly drained; 4 - Moderately well drained; 5 - Well-drained; and 6 - Rapidly drained.

This provides a statement about soil and site drainage likely to occur in most years.

In order to validate the estimated permeability figures to compare to the DECCW guidelines the typical values presented by Hazelton and Murphy 2007 and adapted from Geeves et al 2007 have been used, **table 4**.

Table 4: Typical values of permeability

Texture	Structure	Infiltration	Permeability (mm/hr)
Sandy Loam	Weakly pedal	Very rapid	>120
	apedal	rapid	60-120
Clay loam	Peds evident	Moderately rapid	20-70
	Weakly pedal	moderate	5-20
	apedal	slow	2.5-5
Light Clay	Highly pedal	Moderate	5-50
	Peds evident	Slow	2.5-10
	Weakly pedal	Very slow	<2.5

In order to derive AWC figures to compare to the DECCW guidelines the typical values presented by Hazelton and Murphy 2007 and adapted from Moore et al 2007 have been used, **table 5**.

Table 5: Typical values of Available Water Holding Capacity mm/m

Texture	% clay	Sand size fraction	Moderate to strong structure	Weakly structured to apedal
Sandy Loam	15-20%	Coarse	110-220	50-60
		Medium	110-170	60-100
		fine	170-220	~140
Light sandy clay loam	15-20%	Coarse	120-150	50-60
		Medium	170-220	90-100
		fine	~180	100-120
Sandy clay loam	20-30%	-	130-190	100-130
Clay loam	30-35%	-	120-210	~100
Clay	>35%	-	110-120	90-140

Salt Balance and Leaching Requirement

Where there is a risk of adverse environmental impacts from salinity some leaching of salts from the soil is required to maintain low root zone salinity levels to continue sustainable agricultural production, **figure 6**.

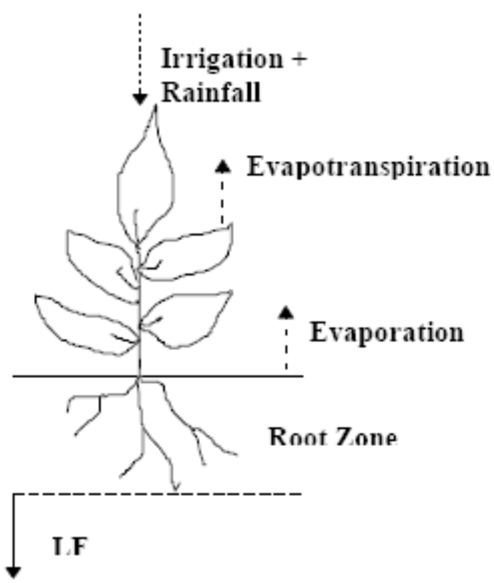

Figure 6: Schematic representation of leaching requirement

The leaching requirement has been calculated as per the FAO, Water Quality for Irrigation paper, Ayers and Wescott 1989 and DECCW 2004. The FAO and DEC model has been used in preference to software such as SALF and SALF PREDICT as the software is based on summer rainfall areas and should be used with some caution in

winter rainfall areas, QLD DPI 2001. The soil salinity thresholds are from ANZECC 2000 & DECCW 2004.
The FAO leaching requirement calculation is as follows:

$$\frac{\text{Irrigation water salinity dS/m}}{5 \times (\text{soil salinity threshold ECe dS/m}) - \text{irrigation water salinity}} \times 100$$

At the ROBE site the following applies:

Irrigation water salinity = 1.09dS/m
Soil salinity threshold = 6 dS/m wheat, 2 dS/m lucerne, 5.6 dS/m ryegrass,

Wheat: 1.09 / ((5 × 6) – 1.09) × 100 = 4%
Lucerne: 1.09 / ((5 × 2) – 1.09) × 100 = 12%
Perennial Ryegrass: 1.09 / ((5 × 5.6) – 1.09) × 100 = 4%

The calculation indicates that for wheat, lucerne and ryegrass an additional 4%, 12% and 4% respectively of water would need to be applied to the irrigation areas to sufficiently leach salt from the soil profile so crop yield is not impacted upon. The additional leaching effect of winter rainfall needs to be considered that will give an overall reduction in soil salinity.

DEC 2004 equation for determining the leaching requirement is as follows:

The rate of salt accumulation depends on a number of factors including the effluent salinity, hydraulic loading, rainfall and resulting natural leaching. One simple method for determining the fraction of irrigation water required to leach salts is to use the following equation:
EC (irrigation water) ÷ EC (50% yield reduction)
Where:
EC (irrigation water) = electrical conductivity (dS/m) of the irrigation water
EC (50% yield reduction) = electrical conductivity (dS/m) of the drainage water at which the relative crop yield is reduced by 50%

Based on the above equation calculations the leaching requirements for wheat, lucerne and ryegrass are 8%, 11% and 9% respectively, which are similar in value to the FAO calculations.

The above calculations should be used as a guide only and a more site specific model can be developed once irrigation and daily scheduling commences. However, the most direct way to determine the need for deliberate leaching of salt is to monitor salt levels in the lower part of the plant root zone. If these start to increase to above acceptable levels then leaching is required, DECCW 2004.

3. CONCLUSION

The conclusions from the report are as follows:

- The area of land identified is capable of receiving the quantity of treated effluent produced by the IOPP in a normal year as defined by the calculations provided in the SWMP;
- the irrigated water quality presented in the SWMP will be suitable to apply to the soil and complies with relevant DECCW guidelines;
- the soils are highly suitable for effluent irrigation in accordance with DEC guidelines; and
- It is unlikely that harmful environmental impacts will be registered with adherence to the SWMP.

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5. APPENDIX

Soil Survey Log Sheets

Site	Horizon	Layer Depth cm	Colour	Texture	Mottles	Structure	Ped Strength	Coarse Fragment %	Fragment Size mm	Fragment Shape	Fragment Lithology	Reaction to HCl	Ksat	Drainage	Dispersion
1	A	0-20	RY-	LS	-	GR	W	-	-	-	-	N	4	5	N
	B1	20-40	YR-	SCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	40-90	RY-	SiC	2rb	MASS	M	-	-	-	-	N	2	3	P
	C	90-150	YR-	SiC	3rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
2	A	0-15	RB-	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B1	15-45	YR	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	45-70	RY-	SiC	2rb	MASS	M	-	-	-	-	N	2	3	P
	C	70-150	YB	LC	3rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
3	A	0-10	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B1	Oct-50	YR	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	50-90	RY	SiC	1rb	MASS	M	-	-	-	-	N	2	3	P
	C	90-150	YB	LC	2rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
4	A	0-20	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B1	20-50	YR	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	50-90	RY	SiC	1rb	MASS	M	-	-	-	-	N	2	3	P
	C	90-150	YB	LC	2rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
5	A	0-20	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B	20-60	YR	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	C	60-150	YB	SiC	2rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
6	A	0-20	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B	20-80	R+	CL	-	SB	M	-	-	-	-	N	3	4	N
	C	80-150	YB	SiC	2rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
7	A	0-15	RB	SL	-	SB	W	-	-	-	-	N	3	4	N
	B1	15-50	YR	SCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	50-80	RY	SCL	1r	SB	W	-	-	-	-	N	2	3	P
	C	80-150	YB	SiC	2rb	MASS	M	<5	<5	A/R	GR/QZ	N	2	3	
Comments															
8	A	0-20	RB	SL	-	SB	W	-	-	-	-	N	3	4	N
	B1	20-60	R-	SCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	60-90	RY	SCL	2r	SB	W	-	-	-	-	N	2	3	P
	C	90-150	YB	SiC	3rb	MASS	M	<5	<5	A/R	GR/QZ	N	2	3	P
Comments															
9	A	0-20	RB	FSL	-	SB	M	-	-	-	-	N	3	4	N
	B	20-50	R-	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	C	50-150	YB	SiC	3rb	MASS	M	<5	<5	A/R	GR/QZ	N	2	3	P
Comments															
10	A	0-15	RB	FSL	-	SB	M	-	-	-	-	N	3	4	N
	B1	15-40	R-	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	40-70	RY	SCL	2rb	SB	M	-	-	-	-	N	2	3	P
	C	70-150	YB	SiC	3rb	MASS	M	-	-	-	-	N	2	3	P
Comments															

Soil Analysis

Site	Horizon	Layer Depth cm	Colour	Texture	Mottles	Structure	Ped Strength	Coarse Fragment %	Fragment Size mm	Fragment Shape	Fragment Lithology	Reaction to HCl	Lab EC uS/cm	Slaking	Dispersion
11	A	0-20	RB	FSL	-	SB	M	-	-	-	-	N	3	4	N
	B	20-70	R-	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	C	70-150	YB	SiC	2rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
12	A	0-15	RB	FSL	-	SB	M	-	-	-	-	N	3	4	N
	B	15-75	R+	CL	-	SB	M	-	-	-	-	N	3	4	N
	C	75-150	YB	SiC	2rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
13	A	0-20	RB	SL	-	GR	W	-	-	-	-	N	3	4	N
	B	20-65	R-	SCL	-	SB	M	-	-	-	-	N	3	4	N
	C	65-150	YB	SiC	3rb	MASS	M	<5	<5	A/R	GR/QZ	N	2	3	P
Comments															
14	A	0-20	RB	SL	-	GR	W	-	-	-	-	N	3	4	N
	B1	20-50	R-	SCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	50-80	RY	SCL	2r	SB	M	-	-	-	-	N	2	3	P
	C	80-150	YB	SiC	3rb	MASS	M	-	-	-	-	N	2	3	P
Comments															
15	A	0-20	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B1	20-50	RB	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	50-80	RY	FSCL	2r	SB	M	-	-	-	-	N	2	3	N
	C	80-150	YB	SiC	3rb	GR	M	-	-	-	-	N	2	3	P
Comments															
16	A	0-20	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B1	20-60	RB	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	60-80	RY	FSCL	2r	SB	M	-	-	-	-	N	2	3	P
	C	80-150	YB	SiC	3rb	GR	M	-	-	-	-	N	2	3	P
Comments															
17	A	0-15	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	B1	15-40	RB	FSCL	-	SB	M	-	-	-	-	N	3	4	N
	B2	40-65	RY	FSCL	2r	SB	M	-	-	-	-	N	2	3	P
	C	65-150	YB	SiC	3rb	GR	M	<5	<5	A/R	GR/QZ	N	2	3	P
Comments															
18	A	0-10	RB	FSL	-	SB	W	-	-	-	-	N	3	4	N
	A2	10-25	YB-	SL	1b	GR	W	-	-	-	-	N	3	4	N
	B1	25-60	R	FSCL	-	SB	M	-	-	-	-	N	2	3	N
	B2	60-85	R+	FSCL	2r	SB	M	-	-	-	-	N	2	3	P
	C	85-150	YB	SiC	3rb	MASS	M	-	-	-	-	N	2	3	P
Comments															

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Attention: David McMahon

Wednesday, July 28, 2010

NATA Accredited Laboratory
Number: 9597

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LABORATORY ANALYSIS REPORT

Report Number: 1006-0062
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For all enquiries related to this report please quote document number: 1006-0062

Facility:	Order #	
Sample Type	Collected By	Date Received
Soil	DM McMahon	08-June-2010

EAL ID	Client ID. Date/Time sample taken	Test	Result	(units)	Method Reference	Limit of Reporting
10Jun-0213	1, 2, 7, 8, 13, 14 A					
		Exchangeable Aluminium	0.28	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	2.29	cmol/kg	R&H 15A1	0.2
		Emerson Aggregate Test	5	EAT	Analysis by Scone Research Centre, NSW Department of Lands	
		Conductivity	297	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	0.74	cmol/kg	R&H 15A1	0.08
		Nitrogen, total	924	mg/kg	R&H 7A1	2
		Phosphorus Buffer Index	41.2	L/kg	ASPAC 9I4	
		pH (CaCl2)	4.9	pH units	R&H 4B1	
		Extractable Phosphorus (Colwell)	27.6	mg/kg	R&H 9B1	5
		Phosphorus, Total	116	mg/kg	* APHA 3030 E/3120 B	5
		pH	4.8	pH units	R&H 4A1	
		Potassium, exchangeable	0.71	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.11	cmol/kg	R&H 15A1	0.02
		Total Kjeldahl Nitrogen	924	mg/kg	R&H 7A1	2
10Jun-0214	1, 2, 7, 8, 13, 14 B					
		Exchangeable Aluminium	0.44	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	4.30	cmol/kg	R&H 15A1	0.2
		Conductivity	407	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	1.73	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	4.5	pH units	R&H 4B1	
		pH	4.6	pH units	R&H 4A1	

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Facility:	Order #	
Sample Type	Collected By	Date Received
Soil	DM McMahon	08-June-2010

EAL ID	Client ID. Date/Time sample taken	Test	Result	(units)	Method Reference	Limit of Reporting
10Jun-0214	1, 2, 7, 8, 13, 14 B					
		Potassium, exchangeable	0.68	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.30	cmol/kg	R&H 15A1	0.02
10Jun-0215	1, 2, 7, 8, 13, 14 C					
		Exchangeable Aluminium	0.38	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	5.30	cmol/kg	R&H 15A1	0.2
		Conductivity	432	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	4.21	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	4.6	pH units	R&H 4B1	
		pH	4.7	pH units	R&H 4A1	
		Potassium, exchangeable	0.56	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.27	cmol/kg	R&H 15A1	0.02
10Jun-0216	1, 2, 7, 8, 13, 14 D					
		Exchangeable Aluminium	0.07	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	7.00	cmol/kg	R&H 15A1	0.2
		Conductivity	686	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	6.20	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	4.5	pH units	R&H 4B1	
		pH	4.6	pH units	R&H 4A1	
		Potassium, exchangeable	0.90	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.28	cmol/kg	R&H 15A1	0.02
10Jun-0217	3, 4, 9, 10, 15, 16 A					

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Facility:	Order #	
Sample Type	Collected By	Date Received
Soil	DM McMahon	08-June-2010

EAL ID	Client ID. Date/Time sample taken	Test	Result	(units)	Method Reference	Limit of Reporting
10Jun-0217	3, 4, 9, 10, 15, 16 A					
		Exchangeable Aluminium	0.06	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	2.14	cmol/kg	R&H 15A1	0.2
		Emerson Aggregate Test	3(1)	EAT	Analysis by Scone Research Centre, NSW Department of Lands	
		Conductivity	301	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	0.59	cmol/kg	R&H 15A1	0.08
		Nitrogen, total	898	mg/kg	R&H 7A1	2
		Phosphorus Buffer Index	71.7	L/kg	ASPAC 9I4	
		pH (CaCl2)	4.4	pH units	R&H 4B1	
		Extractable Phosphorus (Colwell)	25.6	mg/kg	R&H 9B1	5
		Phosphorus, Total	146	mg/kg	* APHA 3030 E/3120 B	5
		pH	4.4	pH units	R&H 4A1	
		Potassium, exchangeable	0.66	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.03	cmol/kg	R&H 15A1	0.02
		Total Kjeldahl Nitrogen	898	mg/kg	R&H 7A1	2
10Jun-0218	3, 4, 9, 10, 15, 16 B					
		Exchangeable Aluminium	0.22	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	3.06	cmol/kg	R&H 15A1	0.2
		Conductivity	347	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	1.13	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	4.3	pH units	R&H 4B1	
		pH	4.4	pH units	R&H 4A1	

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Facility:

Order #

Sample Type
Soil

Collected By
DM McMahon

Date Received
08-June-2010

EAL ID	Client ID. Date/Time sample taken	Test	Result	(units)	Method Reference	Limit of Reporting
10Jun-0218	3, 4, 9, 10, 15, 16 B					
		Potassium, exchangeable	0.70	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.05	cmol/kg	R&H 15A1	0.02
10Jun-0219	3, 4, 9, 10, 15, 16 C					
		Exchangeable Aluminium	0.10	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	5.48	cmol/kg	R&H 15A1	0.2
		Conductivity	436	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	3.58	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	4.6	pH units	R&H 4B1	
		pH	4.7	pH units	R&H 4A1	
		Potassium, exchangeable	0.56	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.21	cmol/kg	R&H 15A1	0.02
10Jun-0220	3, 4, 9, 10, 15, 16 D					
		Exchangeable Aluminium	0.04	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	5.83	cmol/kg	R&H 15A1	0.2
		Conductivity	501	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	5.19	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	4.7	pH units	R&H 4B1	
		pH	4.8	pH units	R&H 4A1	
		Potassium, exchangeable	1.06	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.37	cmol/kg	R&H 15A1	0.02
10Jun-0221	5, 6, 11, 12, 17, 18 A					

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Facility:	Order #	
Sample Type	Collected By	Date Received
Soil	DM McMahon	08-June-2010

EAL ID	Client ID. Date/Time sample taken	Test	Result	(units)	Method Reference	Limit of Reporting
10Jun-0221	5, 6, 11, 12, 17, 18 A					
		Exchangeable Aluminium	0.08	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	3.19	cmol/kg	R&H 15A1	0.2
		Emerson Aggregate Test	3(1)	EAT	Analysis by Scone Research Centre, NSW Department of Lands	
		Conductivity	317	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	0.87	cmol/kg	R&H 15A1	0.08
		Nitrogen, total	940	mg/kg	R&H 7A1	2
		Phosphorus Buffer Index	57.9	L/kg	ASPAC 9I4	
		pH (CaCl2)	4.7	pH units	R&H 4B1	
		Extractable Phosphorus (Colwell)	25.6	mg/kg	R&H 9B1	5
		Phosphorus, Total	145	mg/kg	* APHA 3030 E/3120 B	5
		pH	4.7	pH units	R&H 4A1	
		Potassium, exchangeable	1.08	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	<0.02	cmol/kg	R&H 15A1	0.02
		Total Kjeldahl Nitrogen	940	mg/kg	R&H 7A1	2
10Jun-0222	5, 6, 11, 12, 17, 18 B					
		Exchangeable Aluminium	0.05	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	7.40	cmol/kg	R&H 15A1	0.2
		Conductivity	509	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	3.49	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	5.4	pH units	R&H 4B1	
		pH	5.4	pH units	R&H 4A1	

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Facility:	Order #	
Sample Type	Collected By	Date Received
Soil	DM McMahon	08-June-2010

EAL ID	Client ID. Date/Time sample taken	Test	Result (units)		Method Reference	Limit of Reporting
10Jun-0222	5, 6, 11, 12, 17, 18 B					
		Potassium, exchangeable	1.24	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	<0.02	cmol/kg	R&H 15A1	0.02
10Jun-0223	5, 6, 11, 12, 17, 18 C					
		Exchangeable Aluminium	0.09	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	9.06	cmol/kg	R&H 15A1	0.2
		Conductivity	568	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	3.98	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	5.2	pH units	R&H 4B1	
		pH	5.3	pH units	R&H 4A1	
		Potassium, exchangeable	1.04	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.07	cmol/kg	R&H 15A1	0.02
10Jun-0224	5, 6, 11, 12, 17, 18 D					
		Exchangeable Aluminium	0.16	cmol/kg	* R&H 15G1	0.01
		Calcium, exchangeable	7.53	cmol/kg	R&H 15A1	0.2
		Conductivity	610	µS/cm	R&H 3A1	1
		Magnesium, exchangeable	4.95	cmol/kg	R&H 15A1	0.08
		pH (CaCl2)	4.9	pH units	R&H 4B1	
		pH	4.9	pH units	R&H 4A1	
		Potassium, exchangeable	1.22	cmol/kg	R&H 15A1	0.05
		Sodium, exchangeable	0.14	cmol/kg	R&H 15A1	0.02

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Sample Type	**Collected By**	**Date Received**
Soil	DM McMahon	08-June-2010

EAL ID	Client ID. Date/Time sample taken	Test	Result (units)	Method Reference	Limit of Reporting

Note:

*NATA accreditation not held for tests marked with **

Signed .... David Wade, Laboratory Manager.

All samples analysed as received.
All soil results are reported on a dry basis.
The EAL takes no responsibility for the end use of results within this report.
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